Developing A Market For Energy Efficiency In India

N. Mohan, Manager - Technical
Energy Efficiency Services Limited
(A JV of PSUs of Ministry of Power, Government of India)
Energy Efficiency Projects For Demand Side Measures

- Agriculture
- Municipalities
- Buildings
- Distribution Efficiency
- DSM Efficient Lighting Programme (DELP)
- Cogeneration & Tri-generation Projects

Implementation Of Central & State Government Policies

- S & L Programs
- SDA Capacity Buildings
- Perform Achieve & Trade Scheme For Industries

Consultancy Services

- Technical Advisory Services
- Policy Advice To The Government
- CSR & Sustainable Development Programme

Development Of Private ESCOs.
Energy Scenario:
India’s present electricity generation is 978 billion kWh and expected electricity demand is about 3400 billion kWh by 2030-31
(As per the 18th Electric Power Surveys (EPS) conducted by Central Electricity Authority (CEA).

Energy Savings Potential:

<table>
<thead>
<tr>
<th>Consumer category</th>
<th>Electricity saving potential (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Urban</td>
<td>15-20%</td>
</tr>
<tr>
<td>Domestic Rural</td>
<td>40-50%</td>
</tr>
<tr>
<td>Commercial buildings (&gt; 500kW connected load)</td>
<td>20%</td>
</tr>
<tr>
<td>Public lightings</td>
<td>50%</td>
</tr>
<tr>
<td>Public Water Works</td>
<td>20-25%</td>
</tr>
<tr>
<td>Industry (including SMEs)</td>
<td>7-10%</td>
</tr>
<tr>
<td>Agriculture pumping</td>
<td>30%</td>
</tr>
</tbody>
</table>
**DSM - STRATEGIES**

“Demand side management (DSM) means actions of a utility, beyond the customer's meter, to alter the end-use of electricity, whether it be to increase demand, decrease it, shift it between high and low peak periods, or manage it when there are intermittent load demands, in the overall interests of reducing utility costs”

The broad set of DSM practices that fall under the scope of this definition is mentioned below.

1. **Load management techniques**
   - Dynamic or real-time pricing - Time of day (TOD) tariffs, load factor and power factor incentives
   - Demand response - Voluntary load curtailment measure adopted to manage peak system load.

2. **Load reduction techniques**
   - Utility sponsored incentives to adopt energy-efficient technologies, equipment, appliances across various classes of end-users in the state's economy

Loss reduction techniques like infrastructure up-gradation, feeder segregation and many other interventions, which are not actions beyond the customer's meter, cannot be considered under the scope of this DSM definition.
### EVOLUTION OF DSM REGULATIONS

May 2010 – Model DSM regulations by Forum of Regulators
15 states - notified DSM regulations
2 states - published draft regulations

<table>
<thead>
<tr>
<th>State</th>
<th>Year of gazetted notification</th>
<th>Year of draft publication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maharashtra</td>
<td>April 2010</td>
<td>×</td>
</tr>
<tr>
<td>Tripura</td>
<td>July 2010</td>
<td>×</td>
</tr>
<tr>
<td>Jharkhand</td>
<td>September 2010</td>
<td>×</td>
</tr>
<tr>
<td>Kerala</td>
<td>×</td>
<td>May 2011</td>
</tr>
<tr>
<td>Jammu and Kashmir</td>
<td>August 2011</td>
<td>×</td>
</tr>
<tr>
<td>Orissa</td>
<td>August 2011</td>
<td>×</td>
</tr>
<tr>
<td>Himachal Pradesh</td>
<td>September 2011</td>
<td>×</td>
</tr>
<tr>
<td>Assam</td>
<td>March 2012</td>
<td>×</td>
</tr>
<tr>
<td>Punjab</td>
<td>March 2012</td>
<td>×</td>
</tr>
<tr>
<td>Gujarat</td>
<td>May 2012</td>
<td>×</td>
</tr>
<tr>
<td>Mizoram and Manipur</td>
<td>June 2012</td>
<td>×</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>February 2013</td>
<td>×</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>April 2014</td>
<td></td>
</tr>
<tr>
<td>State of Goa and Union Territories of Dadra &amp; Nagar Haveli, Daman &amp; Diu, Puducherry, Chandigarh, Andaman &amp; Nicobar Islands, Lakshadweep</td>
<td>May 2014</td>
<td>×</td>
</tr>
<tr>
<td>Bihar</td>
<td>August 2014</td>
<td>×</td>
</tr>
<tr>
<td>Haryana</td>
<td>×</td>
<td>August 2014</td>
</tr>
<tr>
<td>Delhi</td>
<td>October 2014</td>
<td>×</td>
</tr>
</tbody>
</table>
DSM PLANNING PROCESS

DSM regulations states:
Distribution Licensee shall undertake load research to identify the target consumer segment/s and end uses for DSM programmes to build the necessary database.

Load Research:
Activity embracing the measurement and study of the characteristics of electric loads to provide a thorough and reliable knowledge of trends, and general behavior of the load characteristics of the customers serviced by the electrical industry.

- Domestic
- Urban/Rural
- Industry
  - HT/LT/industry output
- Agriculture
  - HT/LT/agro-climatic profile
- Commercial
  - Large/small
- Municipal
DSM PLANNING PROCESS

Why load research?

Flat vs skewed load shape

- **Flat curve**
  - Even distribution of fixed costs of generators
  - Reduced loss of surplus power during off peak periods
  - Reduced costs of short/medium term power

- **Skewed curve**
  - Uneven distribution of fixed costs of generators
  - High loss of surplus power during off peak periods
  - High costs of short/medium term power

Flattening the load curve helps DISCOMs to optimize its power procurements costs

- Load research
- Resource potential assessment
- Cost effectiveness assessment
- Design of DSM programs
DSM IMPLEMENTATION MODELS - ESCO APPROACH

Shared Savings

Energy Services, Equipment, Installation, M&V of Savings

Shared Savings Based on Performance

ESCO

Debt Payment

Loan

Financial Institution

Client

or

Guaranteed Savings

Achieved Energy Savings

Bank loan to end-users. Client carries credit risk.

Client usually retains a portion of the savings

Client pays the ESCO after implementation based on performance

ESCO reimburses the loan directly to the bank

ESCO reimburses client for any underperformance

Financial Institution

Client
• 8.5 b KWh consumption annually (2012-13) – growing at CAGR of 7%
• Potential savings of upto 55% possible by retrofits by LEDs
• Additional 15-25% savings by intelligent street light management – daylight savings/ dimming, etc
• Savings of 5 b KWh possible at national level
• Cost savings of Rs. 2500 crores annually

Source: 18th EPS, CEA
ESCO - MAJOR CHALLENGES
FOR STREETLIGHT IMPLEMENTATION

**Baseline:** Inadequate data availability

**Billing:** Wide variation in billed load & actual load - 30-50%

**Conforming to Standard:** Lumen output not as per BIS standard.

**Manual operation:** Variation in operating hours results in additional usage of 10-15%

**Payments linked to bill reduction:** In the absence of proper baseline – enhances the technical and financial risk of ESCO

**Payment Security:** Absence of it increase cost of capital and viability

**M&V:** Detailed M&V plan, in the current situation, makes is very difficult for ESCO to arrange finances
STREETLIGHT INFRASTRUCTURE CHALLENGES

Conventional switching Points

Poor wiring arrangements

Under wattage Ballast
DEEMED SAVINGS ESCO APPROACH

DISCOMs
MUNICIPAL BODIES

Service Level Agreement

Technical Performance

Capital Investment

Annuity Payment

Benefits

EESL
STREETLIGHT IMPLEMENTATION METHODOLOGY

- **MOU**
  - MOU to be signed between Municipalities & EESL

- **DPR/ Re Validation Of DPR**
  - Detailed walk through energy assessment for data validation of existing DPR and Joint Verification

- **Technology Demonstration**
  - To assess actual energy savings and determination of annuity payments and finalising technical specifications

- **Agreement**
  - Agreement to be signed between Municipalities & EESL for implementation.

- **Payment Mechanism**
  - The Payment security mechanism to be finalized.

- **Implementation**
  - EESL will implement the project based on own resources

- **M & V**
  - Deemed saving approach used
TECHNOLOGY DEMONSTRATION PRINCIPLE

- LED 120W
  - Light output: 30.13 lux

- HPSV 250W
  - Light output: 25.00 lux
Technical Performance

- Free O&M during contract period
- Free replacement warranty for entire contract
- Centralised Monitoring & Control for operational efficiency
- Uptime of lights >95%

Annuity Determination

- Actual cost of procurement
- Actual cost upon rate of debt
- PMC charge up to 5%
- ROE of 16% post tax

Overall savings by accounting electricity bill + O&M charges
Case Study of Streetlight Project

Project Area – Greater Vishakhapatnam Municipal Corporation

- Total number of streetlights: 91775
- Existing annual energy consumption: 36.01MU
- Post LED retrofit annual energy consumption: 14.92MU
  Energy Savings per annum: 21.09MU
- Existing expenditure on energy consumption: 23.63Cr
- Existing maintenance expenses: 6.49Cr
  Total existing expenditure on streetlights: 30.12Cr
- Post LED retrofit energy consumption: 9.79Cr
- EESL annuity payment: 18.40Cr
  Total revised expenditure on streetlights: 28.19Cr
- Net benefit to GVMC: 1.93Cr
- Project period: 7 years.
<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name of the ULB</th>
<th>Project Status</th>
<th>No. of streetlights (Nos.)</th>
<th>Estimated Investment (Rs. Crs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nashik Municipal Corporation</td>
<td>Under Implementation</td>
<td>70,000</td>
<td>80</td>
</tr>
<tr>
<td>2</td>
<td>Electricity Department, Puducherry</td>
<td>Project agreement under execution</td>
<td>46,000</td>
<td>37</td>
</tr>
<tr>
<td>3</td>
<td>Greater Vishakhapatnam Municipal Corporation (GVMC)</td>
<td>Under Implementation</td>
<td>90,000</td>
<td>65</td>
</tr>
<tr>
<td>4</td>
<td>Municipal Corporation of Delhi (SDMC)</td>
<td>Project agreement signed</td>
<td>198,000</td>
<td>180</td>
</tr>
<tr>
<td>5</td>
<td>Agartala, Tripura</td>
<td>Project implementation under progress</td>
<td>33,000</td>
<td>13</td>
</tr>
<tr>
<td>6</td>
<td>Andhra Pradesh – 13ULBs</td>
<td>Project under approval phase</td>
<td>38,000</td>
<td>17</td>
</tr>
<tr>
<td>7</td>
<td>Rajasthan – 13ULBs</td>
<td>Project under approval phase</td>
<td>240,000</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>496</strong></td>
<td></td>
</tr>
</tbody>
</table>
DELP SCHEME STRUCTURE

• Provide each grid-connect household up to 4 LEDs as replacement of incandescent bulbs.
• Treats EE as a resource – enhances the value for policy makers/ stakeholders
• Long term contract with Regulatory approvals – reduces investment risks
• Contracts akin to PPAs – easy to understand for Utilities/ regulators
• Payment security in-built – use of revolving LCs
• Obviates the need for Regulators to levy DSM charge which may result in higher tariffs – acceptability of the approach increases
• First Project under DELP-SOP in India approved by Joint Electricity Regulatory Commission on – May, 2014 – 650,000 incandescent bulbs replaced by LEDs – LEDs given at a cost of INR 10
• No upfront cost for utilities in implementing the measures
### IMPLEMENTATION MODELS

<table>
<thead>
<tr>
<th>DELP-SOP Model</th>
<th>DELP-On Bill Financing Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both DELP models are designed under the Demand Side Management (DSM) regulatory framework of DISCOMs.</td>
<td>Implementation will not have any financial burden to the ARR of the DISCOMs, as project investment would be recovered from consumers and through subsidy of Government.</td>
</tr>
<tr>
<td>Project investment would be recovered from DISCOMs from the resultant energy savings as specified in the DSM project duly approved by the Regulatory Commission.</td>
<td>The scheme proposes to provide up to four 7-Watt LED bulbs to household consumers at an upfront cost of Rs.10 each and the balance Rs.120 will be recovered from the consumers’ electricity bill over a period of 12 months at the rate of Rs. 10 every month. Any gap between the total project cost and amount to be recovered from consumers, shall be recovered from subsidy by Government or Ministry of Power.</td>
</tr>
<tr>
<td>The scheme proposes to provide up to four 7-Watt LED bulbs to household consumers at a cost of Rs.10 each as replacements to 60W ICLs and/or 11~14W CFL and investment of EESL is recovered through sharing of resultant energy savings with the DISCOM under a regulatory oversight.</td>
<td></td>
</tr>
<tr>
<td>Consumer participation would be encouraging, as scheme provide LED bulbs at Rs. 10 each.</td>
<td>Limited participation owing to liability on consumers for monthly repayment for LED Bulbs over 1 year.</td>
</tr>
<tr>
<td>No pre-registration formalities required.</td>
<td>Pre-registration of all consumers in order to make them eligible for the scheme.</td>
</tr>
<tr>
<td>Energy savings will be shared to repay the project investment of EESL.</td>
<td>Entire energy savings will be retained by DISCOMs.</td>
</tr>
</tbody>
</table>
DELP METHODOLOGY OF EESL

- EESL will, in consultation with DISCOM, select an area for implementation of DELP.
- EESL, DISCOM and Regulatory Body, will agree on a DSM based mechanism to service investments
- EESL will undertake awareness and outreach of the scheme to household. It will provide up to 4 LEDs per household at Rs.10/lamp as replacement for working ICLs
- EESL and DISCOM will undertake distribution of LEDs to every household and maintain a list of such distribution.
- For monitoring purposes, third-party verifier will select a random sample of household for annual verification.
- Robust mechanism will be built to prevent LED leakage
- ICLs will be collected and destroyed as per relevant environmental norms
Real-Time M&V

- A representative sample of houses will be selected for continuous real-time measurement.
- Usage hours and energy savings of the installed 7W LEDs that replace 60 W incandescent are recorded and monitored.
- RFID tags are fixed on LEDs that in turn uses a computer chip and antennas to record and transmit measurements to a web enabled system that is remotely accessible.
- Readings will be taken for ascertaining the usage pattern in real-time.

On average 1.1 lakh units per day savings will be achieved in Pudicherry. Based on the results, the annual savings for 6.5 Lakhs will be 43 MU.
# Case Study Delp

## Project Scenario

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Unit</th>
<th>Guntur</th>
<th>Anantapur</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of LED Bulbs offered per Household</td>
<td>Number</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Number of LED Bulbs offered under this Scheme</td>
<td>Number</td>
<td>1,842,000</td>
<td>1,240,000</td>
<td>3,082,000</td>
</tr>
<tr>
<td>Energy Savings per Annum under the Scheme on account of Demand Reduction (MUs) - Guntur</td>
<td></td>
<td>114.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Savings per Annum under the Scheme on account of Demand Reduction (MUs) - Anantpur</td>
<td></td>
<td>77.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Procurement Cost per Unit (INR)</td>
<td></td>
<td>2.00%</td>
<td>5.6304</td>
<td></td>
</tr>
<tr>
<td>Benefit - Savings in Power Procurement Cost per Annum (INR Crores) - Guntur</td>
<td></td>
<td>64.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefit - Savings in Power Procurement Cost per Annum (INR Crores) - Anantpur</td>
<td></td>
<td>43.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payout - Payment to EESL through ARR (INR Crores)</td>
<td></td>
<td>30.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Impact on ARR</td>
<td></td>
<td>77.14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Delp SOP Price per Unit

1.6050
What led to this market transformation?

- EESL’s DELP
  - Enabled large procurement of LEDs
  - Engagement of Lighting Industry for promotion of LEDs
  - 6 Lac LED Bulb procurement - Puducherry

- EESL’s DELP
  - Aggregation & procurement of 20Lacs LED Bulbs for DELP - Guntur

- EESL’s DELP
  - Increased participation
  - Bulk procurement – 30lac LED Bulbs

PRICE TREND OF LED BULBS

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1200</td>
<td>1000</td>
<td>800</td>
<td>310</td>
<td>204</td>
<td>150</td>
</tr>
</tbody>
</table>

PRICE OF LED BULB (Rs.)
EESL AgDSM METHODOLOGY

Memorandum of Understanding
- MoU to be signed between DISCOM & EESL

DPR/ Re Validation Of DPR
- Detailed energy audit for existing pumps

Technology Selection
- To assess actual energy savings and finalising technical specifications

Agreement
- Agreement to be signed between DISCOM & EESL for implementation.

Payment Mechanism
- The Payment security mechanism to be finalized - ESCROW

Implementation
- EESL will implement the project based on own resources

M & V
- Deemed saving approach used

Subsidy savings to States
## AGRICULTURE DSM

### AgDSM HESCOM

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Units</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pumps replaced</td>
<td>Nos.</td>
<td>599</td>
</tr>
<tr>
<td>Energy Savings achieved per annum</td>
<td>MUs</td>
<td>29.9</td>
</tr>
<tr>
<td>Total Investment</td>
<td>INR Crores</td>
<td>2.61</td>
</tr>
<tr>
<td>Debt-Equity Ratio</td>
<td>%</td>
<td>0:100</td>
</tr>
<tr>
<td>Monthly Payments to EESL</td>
<td>INR Crores</td>
<td>0.10</td>
</tr>
<tr>
<td>Payment Mechanism</td>
<td></td>
<td>Through ESCROW</td>
</tr>
<tr>
<td>Return on Equity or Equity IRR per annum</td>
<td>%</td>
<td>15.49%</td>
</tr>
<tr>
<td>Present status</td>
<td></td>
<td>Implementation completed on 31.12.2013. Regular payment are being received.</td>
</tr>
</tbody>
</table>

### Sl. No. | Name of Electricity Distribution Company | Nos. of pump sets | Estimated Investment (Rs. Crore) | Present Status |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hubli Electricity Supply Company Limited (HESCOM), Hubli, Karnataka</td>
<td>11013</td>
<td>55</td>
<td>First phase of the project completed – 37% savings achieved consistently for last 6 months. Second phase implementation under finalisation.</td>
</tr>
<tr>
<td>2</td>
<td>Chamundeshwari Electricity Supply Company (CESC), Mysore, Karnataka</td>
<td>1337</td>
<td>5</td>
<td>Project under implementation. POWERGRID is the implementing partner – to be completed by December, 2014.</td>
</tr>
<tr>
<td>3</td>
<td>Bangalore Electricity Supply Company (BESCOM), Bangalore, Karnataka</td>
<td>100,000</td>
<td>400</td>
<td>DPR for 25,000 pumps submitted – final decision of implementation and M&amp;V awaited.</td>
</tr>
<tr>
<td>4</td>
<td>APEDCL</td>
<td>3,000</td>
<td>15</td>
<td>DPR revalidation under process – implementation to start by November, 2014</td>
</tr>
<tr>
<td>5</td>
<td>APEDCL, APSPDCL</td>
<td>30,000</td>
<td>150</td>
<td>Segregated feeders being identified. DPR preparation to commence in August</td>
</tr>
</tbody>
</table>

Total 1,45,350 | 625 |
Buildings

Yojana Bhawan Snapshot

- Total energy consumption before retrofit 29 Lac KWh
- Total energy bill before retrofit Rs. 170 Lac
- Main equipment replaced
  - 591 nos. of old fans with BEE 5 star fans
  - 2176 lighting points with LED retrofits
  - 22 ACs retrofits (all 1.5 TR) — 15 window and 7 split
  - 15 window AC 1.5 TR BEE 5 star for 1st floor to replace ductable units usages
  - 328 nos. of micro processor AC energy savers
  - 1 no. of 15 HP water pump replaced with energy efficient 12.5 HP pump
  - Energy Management System (EMS) to optimize operational controls and enhance savings
- Total capital cost Rs. 85 Lac (EMS cost excluded about Rs. 10 Lac)
- Energy consumption after retrofit 21.5 Lac KWh
- Electricity bill after retrofit Rs. 113 Lac
- Energy Savings – 7.5 Lac KWh

Work in Shram Shakti Bhavan under progress
15 other buildings taken up